

REMARKS

Favorable reconsideration of this application in light of the following remarks is respectfully requested. Claims 1-8 and 14-17 are currently pending. Claims 1, 4 and 14 are amended by the present Amendment to correct minor typographical errors.

In the Office Action dated February 24, 2004, claims 1-3 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 5,698,464 to Tsunoda in view of U.S. Patent 6,136,654 to Kraft et al. Claims 4, 8, and 14 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 5,972,804 to Tobin in view of Tsunoda. Further, claims 5-7 and 15-17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Tobin and Tsunoda, as applied to claims 4 and 14, and further in view of Kraft. The rejections are traversed for the following reasons.

Applicant thanks Examiner Maldonado and Examiner Fourson for the courtesy of an interview granted to Applicant's representative, Jonathan A. Hack, on June 23, 2004. During the interview, Applicant's representative presented arguments detailing how the cited references do not disclose recited claims. Examiner Maldonado indicated that he would reconsider the outstanding grounds of rejection upon formal submission of these remarks. Accordingly, Applicant now submits in this response the remarks previously presented to the Examiners during the interview.

The Rejection of Claims 1-3

In the Office Action, claims 1-3 were rejected under 35 U.S.C. §103 (a) as being unpatentable over Tsunoda in view of Kraft. Applicant respectfully traverses this rejection.

Applicant respectfully submits that Tsunoda and Kraft, either singly or in combination, fail to disclose a method for forming a MOS transistor gate dielectric comprising, *inter alia*, exposing the oxide to a high-density nitrogen plasma and annealing the oxynitride layer in N₂O to form an oxynitride layer with a nitrogen concentration with less than 10% variation across the oxide layer. Further, Applicant respectfully submits that there is no motivation to combine Tsunoda and Kraft as suggested by the Examiner in the outstanding Office Action.

Tsunoda discloses forming a silicon oxynitride film having a nitrogen concentration of about 4 atom % by diffusing nitrogen onto defects formed by x-ray or ultra-violet (UV) irradiation in a silicon oxide film. See col. 3, lines 17-23. According to Tsunoda, it is necessary to form the defects by irradiation because more nitrogen can be introduced into the irradiated silicon oxide film than into a silicon oxide film having no defects. See col. 3, lines 17-21. Nitrogen is introduced into the silicon oxide film by diffusion and the nitrogen is retained on the defects because a nitrogen atom bonds to a Si atom having an unpaired electron (i.e., a defect) and enters a Si-H bond. See col. 3, lines 23-28. In Tsunoda, because nitrogen preferentially binds to defects there is no disclosure or suggestion that Tsunoda's method will form a oxynitride layer with a nitrogen concentration with less than 10% variation across the oxide layer, as recited in claim 1. Accordingly, Applicant respectfully submits that Tsunoda fails to disclose, *inter*

alia, exposing the oxide to a high-density nitrogen plasma and annealing the oxynitride layer to form an oxynitride layer with a nitrogen concentration with less than 10% variation across the oxide layer, as recited in claim 1.

In contrast, Kraft discloses a method of forming a silicon oxynitride using a high-density plasma that implants nitrogen into an insulating surface. See col. 3, line 63 through col. 4, line 1. Applicant respectfully submits that Kraft fails to disclose, *inter alia*, annealing the oxynitride layer in N₂O to form an oxynitride layer with a nitrogen concentration with less than 10% variation across the oxide layer.

Applicant respectfully submits that there is no motivation to combine the method disclosed by Tsunoda with the method disclosed by Kraft. Specifically, there is no motivation to substitute Kraft's high-density plasma method of forming an oxynitride layer for Tsunoda's method of irradiating a silicon oxide film to form defects and binding nitrogen to the defects. In particular, there is no disclosure or suggestion that Kraft's high-density plasma method forms a high number of defects required by Tsunoda. Indeed, Kraft discloses repairing any dielectric and/or substrate damage. See Kraft col. 5, lines 9-15.

Further, there is no motivation to combine parts of Kraft's process with Tsunoda's process because there is no indication that nitrogen implanted by a high-density plasma, as disclosed by Kraft, into a silicon oxide having a substantial number of defects, as disclosed by Tsunoda, would form an oxynitride layer with a nitrogen concentration with less than 10% variation across the oxide layer as recited in claim 1.

Moreover, the material formed by the method disclosed by Tsunoda is different from the material formed by the method disclosed by Kraft. In particular, Tsunoda's

oxynitride comprises a substantial number of defects. In contrast, Kraft discloses a material that has had dielectric damage repaired. Further, Tsunoda's oxynitride film has a maximum nitrogen concentration of 4 atomic % while embodiments shown in Figure 5 of Kraft include a maximum nitrogen concentration of over 15 atomic %. Therefore, Tsunoda's oxynitride includes a substantial number of defects and a peak nitrogen concentration of 4 atomic % while embodiments of Kraft include repairing damage to the oxynitride and include peak nitrogen concentrations of over 15%.

Accordingly, Applicant respectfully submits that Tsunoda and Kraft, either separately or in combination, fail to disclose or suggest the elements recited in claim 1; there is no motivation to combine Tsunoda with Kraft; and the material formed according to the method of Tsunoda is different from the material formed by the method of Kraft. Therefore, Applicant respectfully submits that claim 1 is in condition for allowance.

With respect to claim 2, Applicant respectfully submits that Tsunoda and Kraft, either singly or in combination, fail to disclose, *inter alia*, exposing the oxide layer to a high-density plasma comprising a plasma level of 700-900 watts. As mentioned above, Tsunoda irradiates a silicon oxide film with x-ray or UV radiation. Tsunoda does not disclose or suggest exposing an oxide layer to a high density nitrogen plasma. In addition, while Kraft discloses exposing an oxide layer to high density plasma, Kraft uses a power level different than that claimed in claim 2 of the present application. In particular, Kraft discloses embodiments using a plasma power level of 2000 watts. See, for example, col. 5, lines 29-60. Accordingly, the material formed using a plasma power level of 700-900 watts, as recited in claim 2, would not be the same as the material

formed using a plasma power level of 2000 watts, as disclosed in Kraft, as asserted by the Examiner. Therefore, for the foregoing reasons, Applicant respectfully submits that claim 2 is in condition for allowance.

In addition, claims 2 and 3 depend from claim 1 and are thus allowable for at least the same reasons that claim 1 are allowable, as well as for their additional recitations. Therefore, Applicant respectfully submits that claims 2 and 3 are also allowable over Tsunoda and Kraft, either singly or in combination.

The Rejection of Claims 4, 8, and 14

In the Office Action, claims 4, 8, and 14 were rejected under 35 U.S.C. §103 (a) as being unpatentable over Tobin in view of Tsunoda. Applicant respectfully traverses this rejection.

As detailed above, Tsunoda discloses the necessity of forming a substantial number of defects in a silicon oxide film in order to form a silicon oxynitride film having a peak nitrogen concentration of 4 atom %. See, for example, col. 3, lines 17-23.

Tobin discloses a method of forming a silicon nitride layer by a low pressure chemical vapor deposition (LPCVD) technique and controlling the introduction of oxygen into the silicon nitride to form an oxynitride layer. See col. 5, lines 7-15.

Applicant respectfully submits that there is no motivation to combine the method of Tsunoda with the method of Tobin and that the material formed by the process disclosed in Tsunoda is substantially different than the material formed by the process disclosed by Tobin.

In contrast to forming the required defects of Tsunoda, Tobin expressly teaches away from forming defects, also called traps. For example, Tobin states, "Traps are generally portions of an interface or layer that has dangling bonds. Traps generally are not desired and should be avoided if possible." See Tobin col. 3, lines 56-58. Further, Tobin discloses that silicon nitride films with a large number of traps (i.e., defects) tend to have a high hydrogen content. See col. 3, lines 14-18. Further, Tobin discloses, "Hydrogen related traps in the bulk increase the leakage current of the film." See col. 3, lines 54-56. As such, Tobin suggests that a silicon nitride film with a substantial number of defects would be inoperable for Tobin's intended purpose. Accordingly, Applicant respectfully submits that there is no motivation to combine Tsunoda's method of forming a high number of defects in a silicon oxide film in order to form a silicon oxynitride film with Tobin's method of explicitly avoiding forming defects. Further, the resulting material formed by the combination of Tsunoda and Tobin would be inoperable for the intended purpose disclosed by Tobin.

Moreover, the material formed by the method of Tsunoda is significantly different than the material formed by the method of Tobin. In particular, Tsunoda forms a silicon oxide film with a high number of defects and a nitrogen concentration of 4 atom % and Tobin forms a silicon nitride film with as few defects as possible and with a controlled oxygen concentration.

Based on the reasons presented above, Applicant respectfully submits that claims 4, 8, and 14 are in condition for allowance.

In addition, claims 5-8 depend from claim 4 and claims 15-17 depend from claim 14, and thus, are allowable for at least the same reasons that claims 4 and 14 are

allowable, as well as for their additional recitations. Therefore, Applicant respectfully submits that claims 5-8 and 15-17 are also allowable over the combination of Tobin and Tsunoda.

The Rejection of Claims 5-7 and 15-17

In the Office Action, claims 5-7 and 15-17 were rejected under 35 U.S.C. §103(a) as being unpatentable over Tobin in view of Tsunoda, as applied to claims 4 and 14, and further in view of Kraft. Applicant respectfully traverses this rejection.

In addition to claims 5-7 and 15-17 being allowable for the reasons mentioned above, Applicant respectfully submits that there is no motivation to combine the disclosure of Tobin with the disclosure of Kraft. As mentioned above, Kraft discloses, *inter alia*, methods for forming a silicon oxynitride layer by introducing nitrogen into a silicon oxide layer using a high-density plasma. In addition to the fact that Tobin first forms a silicon nitride layer and Kraft first forms a silicon oxide layer, Tobin expressly teaches away from using plasma techniques. In particular, Tobin states that plasma techniques "cause plasma damage to devices during the film deposition." See Tobin col. 3, lines 39-40. Further, Tobin discloses, "While plasma processing may allow for the formation of thicker gate oxides using this process, the ambient oxidation of this film is still the limiting factor in the use of this technology." See col. 2, lines 33-36. Tobin suggests that a film formed using plasma will not have Tobin's desired oxygen concentration. Accordingly, Applicant respectfully submits that there is no motivation to combine Tobin with Kraft and that claims 5-7 and 15-17 are in condition for allowance.

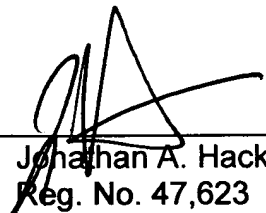
In view of the foregoing amendments and remarks, Applicant respectfully requests the reconsideration of this application and the allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to the Texas Instruments Incorporated Deposit Account 20-0668.

Respectfully submitted,

Dated: July 9, 2004

By: _____


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